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Patent Claims

1. A method for identification when the driver of a vehicle, in particular of a motor vehicle, is not paying attention, comprising the following steps:

- detection of any movement of a steering wheel of the vehicle in the form of a steering wheel angle x (method step S1); and
- identification of a steering quiescent phase and determination of the magnitude of the extent of the steering quiescent phase by evaluation of the detected steering wheel angle and/or its rate of change;

characterized by

- identification of a steering action following the steering quiescent phase and determination of the magnitude of the extent of the steering action by evaluation of the rate of change of the steering wheel angle; and
- determination of a measure of the severity of the inattentiveness by the driver while steering the vehicle by assessment of the result of a link between the extent of the steering quiescent phase and the extent of the steering action.

2. The method as claimed in claim 1,
characterized
in that
the extent of the steering quiescent phase is determined for the time t_1-Δt in the form of a first steering wheel angle fluctuation and/or for the time t_1 in the form of a second steering wheel fluctuation, in each case based on the detected steering wheel angle x.

3. The method as claimed in claim 2,
characterized
in that

- the first steering wheel angle fluctuation is calculated in the form of a steering wheel angle variance $v(x, t_1-\Delta t)$ using the following formula (1):

$$v(x,t_1-\Delta t)=\mathrm{var}(x(t_1-\Delta t), \ldots, x(t_1-\Delta t-T))=\frac{1}{T}\sum_{t=(t_1-\Delta t)}^{((t_1-\Delta t)-T)}(x(t)-\bar{x})^2$$

(1)

where:

$x(t_1-\Delta t)$	represents the steering wheel angle x at the time $t_1-\Delta t$;
Δt	represents a multiple of the sampling interval;
T	represents an observation time window;
$t_1-\Delta t$	represents the observation time;
$\bar{x}$	represents a time mean value of the steering wheel angle x averaged over the observation time window T; and
var	represents the mathematical variance function;

and

the second steering wheel angle fluctuation in the form of a steering wheel angle variance $v(x, t_1)$ is calculated using the following formula (2):

$$v(x,t_1)=\mathrm{var}(x(t_1), \ldots, x(t_1-T))=\frac{1}{T}\sum_{t=(t_1)}^{(t_1-T)}(x(t)-\bar{x})^2$$

(2)

where the variables have the same meanings as in the formula (1).

4. The method as claimed in claim 3,

characterized

in that

the extent of the steering action as well as the linking of the steering quiescent phase and the steering action are determined by formation of a fluctuation ratio $vv(x, t_1)$, preferably as the quotient of the second steering wheel angle variance divided by the first.

5. The method as claimed in claim 4,

characterized

in that the variance ratio $vv(x, t_1)$ is then calculated in accordance with the following formula (3):

$$vv(x, t_1) = \frac{v(x,t_1)}{v(x,t_1 - \Delta t)} . \qquad (3)$$

6. The method as claimed in claim 1,

characterized

in that the extent of the steering quiescent phase is determined as that time period during which the steering wheel angle remains within a predetermined steering wheel angle interval (Δx).

7. The method as claimed in claim 6,

characterized

in that

the steering wheel angle interval is predetermined on the basis of the current speed of the vehicle.

8. The method as claimed in claim 2, 3, 6, or 7,

characterized

in that

the extent of the steering action following a previous steering quiescent phase is determined in the form of the maximum gradient of the steering wheel angle which then occurs.

9. The method as claimed in claim 8,
characterized
in that
the link between the extent of the steering quiescent phase and the extent of the steering action at a time t1 is produced by means of a multidimensional operator, but preferably only when the extent of the steering quiescent phase in the form of its time period is greater than a predetermined minimum time period and the maximum gradient of the steering wheel angle exceeds a predetermined gradient threshold value.

10. The method as claimed in claim 9,
characterized
in that
the multidimensional operator represents a family of characteristics, a weighting function or a logical decision function.

11. The method as claimed in claim 9 or 10,
characterized
in that
the multidimensional operator is dimensioned on the basis of the speed of the vehicle and/or dynamics of the driving style of the driver of the vehicle.

12. The method as claimed in one of claims 4,5 or 9, 10, 11,
characterized
in that,
in a subsequent step (method step S3), the result of the logical operation is mapped in the form of the variance ratio vv(x, t) or of the multidimensional operator, preferably with the aid of the sigmoid function, onto a probability value $P(U_1)$ between 0 and 100%, which represents the inattentiveness by the driver in the steering of the vehicle at the time t_1.

13. The method as claimed in claim 12, characterized by the following further steps for assessment of the fatigue of the driver:

- determination of a first probability vector $O_{n=1}$, whose elements $O_{n=1,k1}$ each represent probability values $P(O_{1,k1})$, of a probability value $P(U_1)$ occurring in individual, predetermined and selected extent levels k_1 where $k_1 \in \{1 \ldots K_1\}$ (method step S4); and
- determination of a fatigue probability vector S', whose elements each represent probabilities P (fatigue level), of the detected inattentiveness by the driver in steering of the vehicle being associated with individual, predetermined and suitably selected fatigue levels, using the following formula (5):

$$S'(t) = O_1^T \cdot B_1; \qquad (5),$$

with

O^T_1 representing the transpose of the first probability vector;

B_1 the matrix B representing predetermined conditional probabilities with respect to the steering inattentiveness, represented by the indicator $n = 1$; and

K_1 representing the number of extent levels for the indicator $n = 1$.

14. The method as claimed in claim 13, characterized by the following further steps:

- determination of further probability vectors $O_{n=2} \ldots O_{n=N}$ whose elements $O_{n,kn}$ were $k_n = 1 \ldots K_n$ each

represent probabilities $P(O_{n,kn})$ of the probability values $P(U_n)$ occurring for other inattentiveness indicators n = 2..N for the driver, in addition to the steering inattentiveness n = 1, in particular the eyelid closure behavior n = 2 or the reaction time n = 3, in individual extent levels k_n, which are predetermined individually for the inattentiveness indicators, and

- the fatigue probability vector S'' in the method step S6 then being calculated using the following formula (6):

$$S''(t) = \prod_{n=1}^{N} O_n^T \cdot B_n \qquad (6),$$

where

N represents the n-th indicator for the inattentiveness by the driver;

O_n^T represents the transpose of the further probability vectors;

B_n represents the matrix B for the indicator n; and

N represents the number of indicators.

15. The method as claimed in one of claims 13 or 14, characterized by

- storage of the fatigue probability vector S'''(t-1); and
- calculation of a more precise fatigue probability vector S'''(t) using the following formula (7) (method step S7):

$$S'''(t) = S''(t) \cdot A \cdot S'''(t-1), \qquad (7)$$

where

A represents the matrix of the conditional probabilities between a fatigue level from the last time step and a current fatigue level.

16. The method as claimed in one of claims 14 or 15, characterized in that, in addition to the steering inattentiveness and the optional further indicators for the inattentiveness by the driver, the method also determines whether the driver is holding a conversation or is using a control element, for example is operating the radio or the glove compartment in the vehicle; and wherein these detected events can be evaluated with the aid of the probabilistic model in order to make a statement about the probability with which it can be assumed that the driver has been distracted, on the basis of the conversation or the control action, and the probability of driver fatigue being the cause of the observed inattentiveness.

17. The method as claimed in one of claims 4, 5 or 9-12,

characterized by the following steps:

- the logical operation is carried out at different times ti where i = 1-I during a predetermined measurement time interval.
- the results of the logical operations relating to the times ti are in each case stored together with the associated weighting factors which represent the driving situation of the vehicle or the current distraction of the driver, in each case relating to the time ti; and
- a weighted result of the logical operation is calculated by mathematical, preferably arithmetic, averaging of the results stored during the measurement time interval, taking into account the weighting factors associated with them.

18. The method as claimed in claim 17,
characterized
in that

the weighting factors are calculated taking into account circadian influencing factors and/or the time since the journey started.

19. The method as claimed in claim 17 or 18,
characterized by
the outputting of information, in particular an audible or visual warning message to the driver of the vehicle, when the preferably weighted result exceeds a predetermined threshold value.

20. A computer program (122) with program code for a controller for identification of inattentiveness by a driver of a vehicle,
characterized
in that
the program code is designed to carry out the method as claimed in one of claims 1-19.

21. A data storage medium
characterized by
the computer program as claimed in claim 20.

22. A controller (100) for identification of inattentiveness by the driver of a vehicle, comprising:

- a steering wheel angle sensor (110) for detection of the current steering wheel angle of the vehicle;
- a control device (120), preferably a microcontroller, for carrying out the method as claimed in one of claims 1-19 in response to the detected steering wheel angle; and
- a warning device (130) for outputting audible and/or visual warning information to the driver when inattentiveness, in particular driver fatigue, has been found when carrying out the method.